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AIR FORCE LOGISTICS COMMAND

MATERIEL MANAGEMENT ANALYSIS

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Air Logistics Early Requirements Technique (ALERT)

FY92-97 Program Objective Memorandum (POM)

Forecasts

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May 1989

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<p>This report documents the 1988 application of the Air Logistics Early Requirements Technique (ALERT) for estimating the FY92-FY97 Program Objective Memorandum (POM) inputs for the Peacetime Operation Spares portion of the aircraft replenishment spares budget (BP15). This is the sixth consecutive year that ALERT has been used to prepare AFLC POM inputs to the Air Staff. ALERT's logic is a combination of statistical forecasts and management adjustments to these forecasts which yield the Command's total peacetime operating stock requirement for the POM period.</p>			
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WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-5001

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SUBJECT Final Report - ALERT FY92-97 POM Forecasts

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1. In this report, we documented the 1988 application of the Air Logistics Early Requirements Technique (ALERT) for estimating the FY92-97 Program Objective Memorandum (POM) inputs for the Peacetime Operation Spares (POS) portion of the aircraft replenishment spares budget (BP15). ALERT's logic is a combination of statistical forecasts and management adjustments to these forecasts which yield the command's total peacetime operating stock requirement for the POM period. We provide our conclusions and actions at attachment 1.

2. Our point of contact is Mr Rob Lucas, HQ AFLC/MMISA, AUTOVON 787-5249.

FOR THE COMMANDER


GERALD G. ELLMYER, Lt Col, USAF
Ch, Mgt Info Systems/Analysis Div
DCS/Materiel Management

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1. Conclusions and Actions
2. Distribution List
3. Final Report



COMBAT STRENGTH THROUGH LOGISTICS

CONCLUSIONS AND ACTIONS

Conclusions

1. AFLC uses the ALERT model to forecast Peacetime Operating Stocks (POS) BP15 POM requirements.
2. The BP15 budget program manager used ALERT to develop the FY92 through FY97 POS POM requirement.
3. The fleet value data required by ALERT are no longer developed by Air Staff.
4. We need to have fleet age data provided to AFLC/MMM in a timely manner for input to the ALERT model.
5. The Air Force will need more accurate POM forecasts at the weapon system level.
6. ALERT develops POM forecasts by weapon system which are then rolled up into a total BP15 requirement.
7. We need a separate ALERT forecast of the total BP15 requirement to use as a cross-check.

Actions

1. Continue to document the annual ALERT forecasts. (OPR: HQ AFLC/MMMA and MMMI)
2. Develop fleet value data for input to the ALERT model. (OPR: HQ AFLC/ACC, OCR: HQ AFLC/MMM)
3. Ensure that fleet age data is received annually in a timely fashion for input to the ALERT model. (OPR: HQ AFLC/ACC, OCR: HQ AFLC/MMM)
4. Analyze the ALERT forecasts for individual weapon systems and develop ways to improve the forecasts as necessary. (OPR: HQ AFLC/MMMA, OCR: MMMI)
5. Develop a total POS BP15 ALERT POM forecast. (OPR: HQ AFLC/MMMA, OCR: MMMI)

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ABSTRACT

This report documents the 1988 application of the Air Logistics Early Requirements Technique (ALERT) for estimating the FY92-FY97 Program Objective Memorandum (POM) inputs for the Peacetime Operation Spares portion of the aircraft replenishment spares budget (BP15). This is the sixth consecutive year that ALERT has been used to prepare AFLC POM inputs to the Air Staff. ALERT's logic is a combination of statistical forecasts and management adjustments to these forecasts which yield the Command's total peacetime operating stock requirement for the POM period.

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EXECUTIVE SUMMARY

The ALERT model has been used by the Air Force Logistics Command since 1984 to project the BP15 aircraft peacetime spares Program Objective Memorandum (POM) requirement. ALERT performs a statistical analysis of historical data to forecast the BP15 Peacetime Operation Spares (POS) requirement by weapon system. The AFLC BP15 budget program managers review the statistical projections and make final adjustments. ALERT is the only BP15 POM forecasting approach sanctioned by Air Staff. This report documents the development of the FY92-FY97 POM forecasts. The following table shows the ALERT estimates for the total BP15 budget for the FY92-FY97 POM.

<u>FY92</u>	<u>FY93</u>	<u>FY94</u>	<u>FY95</u>	<u>FY96</u>	<u>FY97</u>
2442.9	2506.7	2566.9	2608.1	2665.1	2719.3

ALERT uses 16 individual weapon system regression equations to develop each fiscal year's BP15 estimate by weapon system. These individual forecasts are then added together to develop the Air Force total BP15 POM forecast.

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CHAPTER 1

THE PROBLEM

Aircraft replenishment spares (BP15) requirement forecasts are needed by weapon system for input into the Program Objective Memorandum (POM). Due to a lapse of three to seven years between projection and initiation of such requirements in the POM and budget process, the Air Force needs a long range forecasting technique to project the outyear requirements.

Background

AFLC uses the ALERT model to forecast Peacetime Operating Stock (POS) BP15 POM requirements. The ALERT model is a long-range forecasting model used to forecast BP15 peacetime operating stock requirements for the Air Force POM. The once-a-year data gathering process to support ALERT depends heavily upon the timely receipt of the data sources, such as the D041 Central Secondary Item Stratification (CSIS) data, used to develop the weapon system forecasts. Once developed, these forecasts may be adjusted by the BP15 budget manager based on other information which is not easily incorporated into the statistical forecast.

Objectives

1. To run ALERT for forecasting budget requirements for input into the FY92-97 POM.
2. To document the ALERT process for the FY92-97 POM.

CHAPTER 2

We document the development of the FY92 to FY97 POM forecast in three sections. First we describe the ALERT model. In the second section we discuss the results for the FY92 to FY97 forecasts. In the final section, we discuss issues.

ANALYSIS

The BP15 budget program managers used ALERT to develop the FY92 through FY97 POS POM requirement. We document the ALERT model runs for the BP15 POS POM in three parts. First, we describe the model. Then we present the results for the FY92-97 forecasts. Lastly, we discuss issues.

Model Description

We describe the ALERT model in last year's ALERT forecast report [1] for the FY90-94 POM. (This year's POM covers the FY92-97 time period instead of FY91-95. This was done to correspond to the biennial POM cycle dictated by Congress.) We repeat the description here and update it as necessary. We plan to continue updating the ALERT forecasts annually.

ALERT is a multivariate regression based model that uses historical data to predict future POM requirements by weapon system. The model, which previously resided on the Honeywell CREATE computer system, now resides on the Planning, Programming, and Budgeting System (PPBS) Subproject 5 analysis and forecasting region of the Requirements Data Bank (RDB) computer system [3]. The model is programmed in the SAS statistical programming language. ALERT predicts the BP15 Peacetime Operating Stock (POS) POM requirement. The model uses up to eleven years of historical data which includes the following:

1. Past Budget Estimate Submissions for the BP15 POS.
2. The sum of the D041 Central and Secondary Item Stratification (CSIS) extended year buy requirement plus the CSIS Approved Force Acquisition Objective (AFAO) buy requirement for condemnations only (this is the estimate of recoverable buy requirements three to four years from the current June computation).
3. The reciprocal of the present and projected age of the fleet (developed by USAF/AC).
4. The dollar value of the fleet (developed by AFLC/MMM from USAF/AC data).

ALERT is actually a five step process.

Step 1 - Update the ALERT Data Base - In this step, we collect the most

up-to-date data on each of the variables. This includes updating the D041 Central and Secondary Item Stratification (CSIS) data and the age and value of the fleet data and entering them in the data base.

Step 2 - Develop Regression Equations - In this step, we run the ALERT model on the RDB computer which develops regression equations, and then we select the equations that result in the best fit of the data. The criteria used to determine the best fit consist of the following statistical tests: the adjusted r-square (the coefficient of determination), the F statistic, the residual pattern, and the Durbin-Watson test. We documented these statistical techniques in reference [3].

Each weapon system has its own regression equation and its own set of independent variables. Appendix A provides the best set of regression equations for FY91 and FY92 through FY97. We developed a different set of equations for FY92 through FY97 because these forecasts include the FY91 forecasts as historical data. (Using a regression forecast as another data point in developing yet another forecast is a statistical technique called bootstrapping.)

Step 3 - Management Review - The results of step 2 reflect the best set of regression equations and forecasts based on historical data. However, historical data is not always the best prediction of the future. This is because it assumes the forces at work in the past will continue in a predictable way into the future. Therefore, we include a management scrub which provides management a chance to look at the results and identify any known occurrence that would impact the future.

Step 4 - Develop New Regression Equations - We repeat step 2 with the data updated from the management scrub, and we include "dummy" variables to reflect future known occurrences. For example, if the budget program managers know of a significant modification or program change, we adjust the regression equation to account for the change.

Step 5 - Present the ALERT Forecasts - At this point, we present the ALERT forecasts by weapon system and total BP15 requirements to the budget program manager.

Results

In Table 1 below, we present the forecasted dollar values for the BP15 POS POM for FY91. It also shows the adjusted r-square values. The adjusted r-square is known as the coefficient of determination and is defined as the proportion of the total variation in the dependent variable (the forecasted requirement) that is explained by the regression line. A value of 1.00 means that the variation in the dependent variable is totally explained by the regression line.

ALERT POM FORECAST FY91

WEAPON SYSTEM	FY91 FORECAST (IN \$M)	ADJUSTED R-SQUARE
A-7	9.3	0.89
A-10	32.8	0.75
B-1	108.1	0.92
B-52	83.1	0.64
C-5	179.1	0.66
C-130	55.1	0.61
C-135	161.4	0.73
C-141	30.7	0.64
COMMON	330.7	0.77
E-3	11.9	0.83
F-4	35.4	0.73
F-15	210.8	0.17
F-16	198.4	0.85
F-111	133.3	0.80
F100 ENGINE	569.7	0.66
OTHER	289.0	0.74

Table 1

We entered the FY91 forecasts in the ALERT data base as historical data and used it to forecast the BP15 POS for FY92 through FY97. This is a statistical technique known as bootstrapping.

For the ALERT model runs for the FY92 through FY97, we did not use the D041 CSIS data. This is because there is no CSIS data for the POM outyears. In Table 2, we show the FY92 through FY97 POM forecasts by weapon system.

ALERT POM FORECAST
FY92 - FY97

(\$ IN MILLIONS)

WEAPON SYSTEM	FY92	FY93	FY94	FY95	FY96	FY97	ADJUSTED R-SQUARE
A-7	13.2	12.8	12.3	11.9	11.4	11.0	.75
A-10	27.1	22.4	17.8	13.9	10.2	6.5	.74
B-1	116.9	117.8	118.7	120.4	122.1	123.9	.89
B-52	81.4	79.8	78.1	66.3	64.7	63.0	.65
C-5	204.4	216.9	229.3	241.7	254.2	266.6	.70
C-130	52.8	50.7	55.7	53.7	58.7	63.7	.62
C-135	146.7	150.8	155.5	160.9	166.5	172.3	.76
C-141	28.3	25.6	23.3	20.5	18.3	16.2	.63
COMMON	333.2	337.1	341.0	344.9	348.8	352.7	.73
E-3	18.1	17.8	17.5	17.3	17.1	16.9	.83
F-4	11.9	12.1	13.9	16.0	18.1	20.3	.72
F-15	196.9	203.3	209.2	225.5	241.0	256.5	.07
F-16	218.0	233.5	249.1	264.7	280.4	296.0	.89
F-111	135.0	144.6	150.9	137.7	123.5	108.2	.73
F100 ENG	578.6	586.4	593.1	604.3	614.3	622.1	.68
OTHER	280.4	295.1	301.8	308.7	315.8	323.4	.63
TOTAL	2442.9	2506.7	2566.9	2608.1	2665.1	2719.3	

Table 2

When we transferred the ALERT model to the RDB and reprogrammed it using SAS, we included several enhancements which we describe in reference [3]. In the management review of the ALERT forecasts, we now provide the BP15 program managers with a "library" of regression equations and their associated forecasts. The SAS statistical programming develops several such equations for each weapon system using different combinations of the regressor variables. From these different combinations, SAS determines the central tendency of the BP15 POS BES requirement across time and projects that trend into the future. The BP15 program manager then reviews the equations, as necessary, and selects those which best reflect the future POS requirement based on his knowledge of the weapon system, and future occurrences which cannot be accounted for in the historical ALERT data base.

In addition to reviewing the regression equations and results, we review the ALERT data base as necessary, to ensure that it is correct and up-to-date and that all known events are considered. For example, the BP manager had to subtract out non-reporting requirements for both 1985. In 1985, the Air Force procured Single Integrated Operations Plan (SIOP) additive spares support kits as a one time requirement for the B-1. Table 2 above reflects the final ALERT regression results. In Appendix B, we have attached graphs reflecting the forecasted BP15 POM data versus the actual BP15 POS BES requirement (the dependent variable that ALERT forecasted through the POM outyears).

Issues

We need to ensure the integrity of the ALERT data base. Two inputs to ALERT had been developed by USAF/AC. These are the fleet value and fleet age data. The fleet value numbers are no longer being developed by Air Staff, and will need to be developed by AFLC. We need to identify the AFLC OPR for this development effort and ensure timely delivery of this input to the ALERT model. Also, we had difficulty obtaining the fleet age numbers from Air Staff this year. We need to ensure that Air Staff is aware of our continuing need for fleet age data as an input to the ALERT model, and that it will be provided to us annually and in a timely fashion.

In the future, the Air Force will need more accurate POM forecasts at the weapon system level. Today, the funding within the budget program is not specifically tied to one weapon system. Portions of the total BP15 requirement can be shifted from one weapon system to another as conditions may dictate. However, due to an Air Force decision, this will no longer be the case. In the future, funding within a specific budget program (such as BP15) will be tied by the budget managers to the individual weapon system. In a previous report on ALERT, we found that individual weapon system forecasts can be very inaccurate when compared to the total rolled up BP15 forecast [2]. That is, although individual weapon system requirements could be over or under forecasted, these fluctuations tended to cancel themselves out when rolled up into an overall budget program forecast. We need to analyze the ALERT forecasts for individual weapon systems and develop ways to improve the forecasts.

One final issue identified by the BP15 program manager is to develop an ALERT forecast for the total POS BP15 program. Currently, ALERT develops POM forecasts by weapon system and rolls them up for the total BP15 requirement. The BP15 program manager wants a forecast developed for the entire BP15 program. This would serve as a validity check for the current ALERT BP15 POM forecasts. We need to develop a total POS ALERT BP15 POM forecast based on a single statistical function as opposed to the current aggregated ALERT POM forecast.

CHAPTER 3

CONCLUSIONS AND ACTIONS

Conclusions

1. AFLC uses the ALERT model to forecast Peacetime Operating Stocks (POS) BP15 POM requirements.
2. The BP15 budget program manager used ALERT to develop the FY92 through FY97 POS POM requirement.
3. The fleet value data required by ALERT are no longer developed by Air Staff.
4. We need to have fleet age data provided to AFLC/MMM in a timely manner for input to the ALERT model.
5. The Air Force will need more accurate POM forecasts at the weapon system level.
6. ALERT develops POM forecasts by weapon system which are then rolled up into a total BP15 requirement.
7. We need a separate ALERT forecast of the total BP15 requirement to use as a cross-check.

Actions

1. Continue to document the annual ALERT forecasts. (OPR: HQ AFLC/MMMA and MMMI)
2. Develop fleet value data for input to the ALERT model. (OPR: HQ AFLC/ACC, OCR: HQ AFLC/MMM)
3. Ensure that fleet age data is received annually in a timely fashion for input to the ALERT model. (OPR: HQ AFLC/ACC, OCR: HQ AFLC/MMM)
4. Analyze the ALERT forecasts for individual weapon systems and develop ways to improve the forecasts as necessary. (OPR: HQ AFLC/MMMA, OCR: MMMI)
5. Develop a total POS BP15 ALERT POM forecast. (OPR: HQ AFLC/MMMA, OCR: MMMI)

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1. Rexroad, Adrienne, Larry Collins, and Rob Lucas, "Air Logistics Early Requirements Technique (ALERT) FY90-94 Program Objective Memorandum (POM) Forecasts," HQ AFLC/MMMA Technical Report, June 1988.
2. Rexroad, Adrienne and Larry Collins, "ALERT Model Validation," HQ AFLC/MMMA Technical Report, June 1988.
3. Lucas, Rob and Larry Collins, "Transfer of the Air Logistics Early Requirements Technique (ALERT) Forecasting Model from the CREATE Computer System to the Requirements Data Bank (RDB) Computer System," HQ AFLC/MMMA Technical Report, January 1989.

Appendix A
ALERT Regression Equations

Appendix A

ALERT Regression Equations

In this appendix we present the regression equations used to forecast FY91 and FY92 through FY97. In Table A-1 below are the equations for the FY91 forecast.

ALERT POM FORECAST - FY91 REGRESSION EQUATIONS

WEAPON SYSTEM	REGRESSION EQUATIONS	ADJUSTED R-SQUARE
A-7	POSBES = 498.6637 - 1.8273E-05 (TBUY) - 7.3361E-03 (VALUE) - 4.6281 (YEAR) - 691.5511 (AGEREC)	0.8883
A-10	POSBES = 733.0991 - 7.5154 (YEAR) - 1.0790E-05 (TBUY) - 149.0754 (AGEGRE)	0.7458
B-1	POSBES = 289.00256 - 1.9883 (YEAR)	0.9219
B-52	POSBES = 1484.1365 - 11.7438 (YEAR) - 10070.4673 (AGEREC)	0.6441
C-5	POSBES = 5.5870 + 6.2327E-03 (VALUE)	0.6609
C-130	POSBES = 1214.8452 - 6.1750E-05 (TBUY) - 7818.1042 (AGEREC) - 8.4362 (YEAR)	0.6057
C-135	POSBES = -1069.1878 - 4.6311E-05 (TBUY) + 13.7530 (YEAR)	0.7256
C-141	POSBES = 995.4131 - 3.7182E-05 (TBUY) - 9.0238 (YEAR) - 3356.3727 (AGEREC)	0.6448
COMMON	POSBES = 245.9300 + 4.5596E-05 (TBUY)	0.7666
E-3	POSBES = 245.8246 - 1.9112E-05 (TBUY) - 2.5442 (YEAR)	0.8323
F-4	POSBES = -549.91552 - 12.9857E-05 (TBUY) + 1.3993E-02 (VALUE) + 5.4224 (YEAR)	0.7337
F-15	POSBES = -740.6069 - 4.2228E-05 (TBUY) + 10.7968 (YEAR)	0.1696
F-16	POSBES = -1091.8790 + 6.8753E-06 (TBUY) + 14.1240 (YEAR)	0.8512
F-111	POSBES = 3786.83042 + 7.3826E-02 (VALUE) - 57.3648 (YEAR)	0.7952
F100 ENGINE	POSBES = 713.5508 - 1114.9940 (AGEREC)	0.7352
OTHER	POSBES = -4495.3487 - 2.5264E-03 (VALUE) + 60.9594 (YEAR)	0.7352

Table A-1

The adjusted r-square value in Tables A-1 and A-2 are the coefficient of determination. It is defined as being the proportion of the total variation in the dependent variable (POSBES) that is explained by the regression line.

In Table A-2 below are the regression equations for the BP15 POM POS forecast of FY92 through FY97.

ALERT POM FORECAST - FY92 - FY97
REGRESSION EQUATIONS

WEAPON SYSTEM	REGRESSION EQUATIONS	ADJUSTED R-SQUARE
A-7	POSBES = 54.21346448 - 0.44583652 (YEAR)	0.7549
A-10	POSBES = 513.64993 + .01627106 (VALUE) - 6.431657658	0.7446
B-1	POSBES = 43.33600081 + 0.002927883 (VALUE)	0.8938
B-52	POSBES = 1484.49635 - 11.74718849 (YEAR) - 10072.25904 (AGEREC)	0.6540
C-5	POSBES = -938.91306 + 12.42785121 (YEAR)	0.6992
C-130	POSBES = 1222.95187 - 9.17000558 (YEAR) - 7098.04283 (AGEREC)	0.6161
C-135	POSBES = -72.05442266 + .008191279 (VALUE)	0.7637
C-141	POSBES = 559.44986 + 0.02118041 (VALUE) - 8.32407571 (YEAR)	0.6286
COMMON	POSBES = -25.41598214 + 3.89794643 (YEAR)	0.7347
E-3	POSBES = 14.17483254 + 46.17381933 (AGEREC)	0.8296
F-4	POSBES = -128.31952 + .006294832 (VALUE) + 1.05951761 (YEAR)	0.7238
F-15	POSBES = -1662.54344 - 0.006422922 (VALUE) + 23.06569361 (YEAR)	0.0736
F-16	POSBES = -1232.61808 + 15.74490816 (YEAR) + 12.16614263 (AGEREC)	0.8865
F-111	POSBES = 2146.99042 - 0.06473493 (VALUE) - 10747.71479 (AGEREC)	0.7286
F100 ENGINE	POSBES = 713.54662 - 1114.98240 (AGEREC)	0.6829
OTHER	POSBES = 13.59294072 + 0.000837384 (VALUE)	0.6278

Table A-2

Appendix B
Graphical Results of ALERT FY92-97
BP15 POM POS Requirement

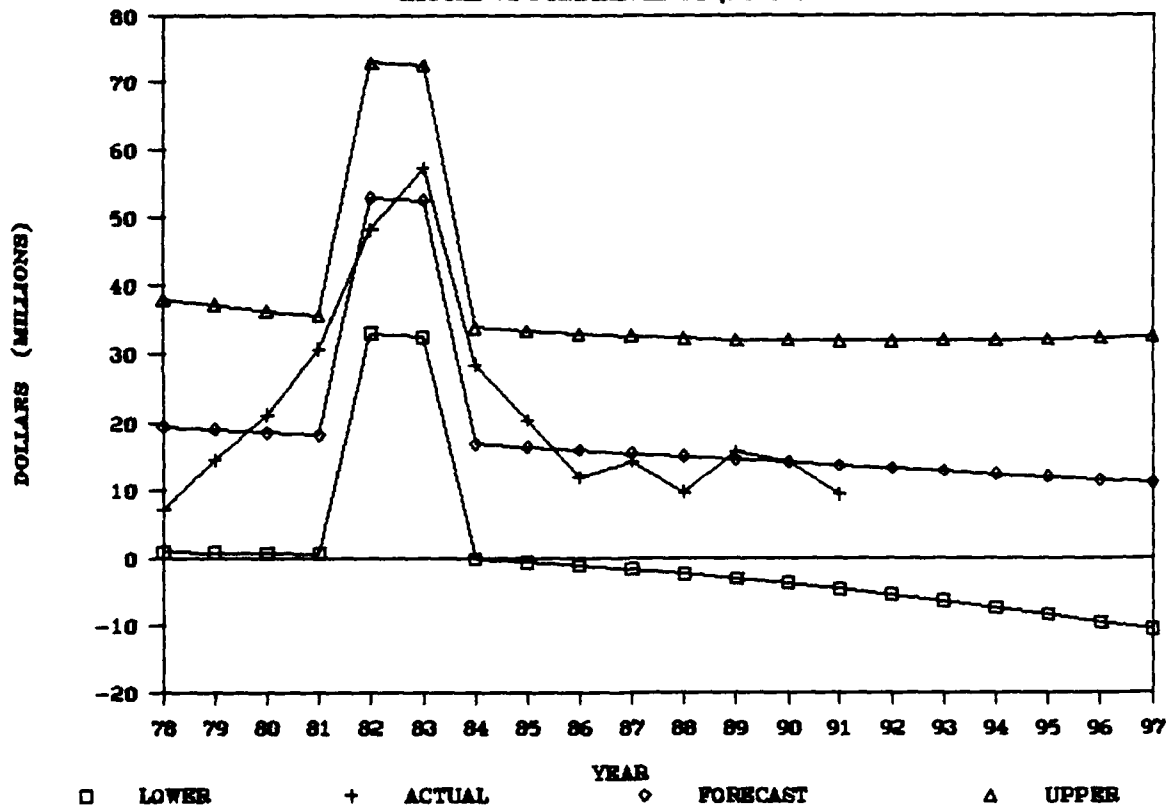
Appendix B

Graphical Results of ALERT FY92-97 BP15 POM POS Requirement

In this appendix, we present the graphical results of the ALERT POM forecast for BP15 peacetime operating stock requirements. These graphs reflect the forecasted BP15 POM (ALERT) data versus the actual BP15 POS BES requirement by weapon system (obtained from the annual BP15 BES reports submitted to Air Staff). Also included in these graphs are the upper and lower 95 percent confidence limits of the forecasted numbers. The confidence limits can be interpreted as follows: for such forecasts as are presented in the graphs, 95 percent of the time we expect the predicted value, when it actually occurs, to fall within the upper and lower limit.

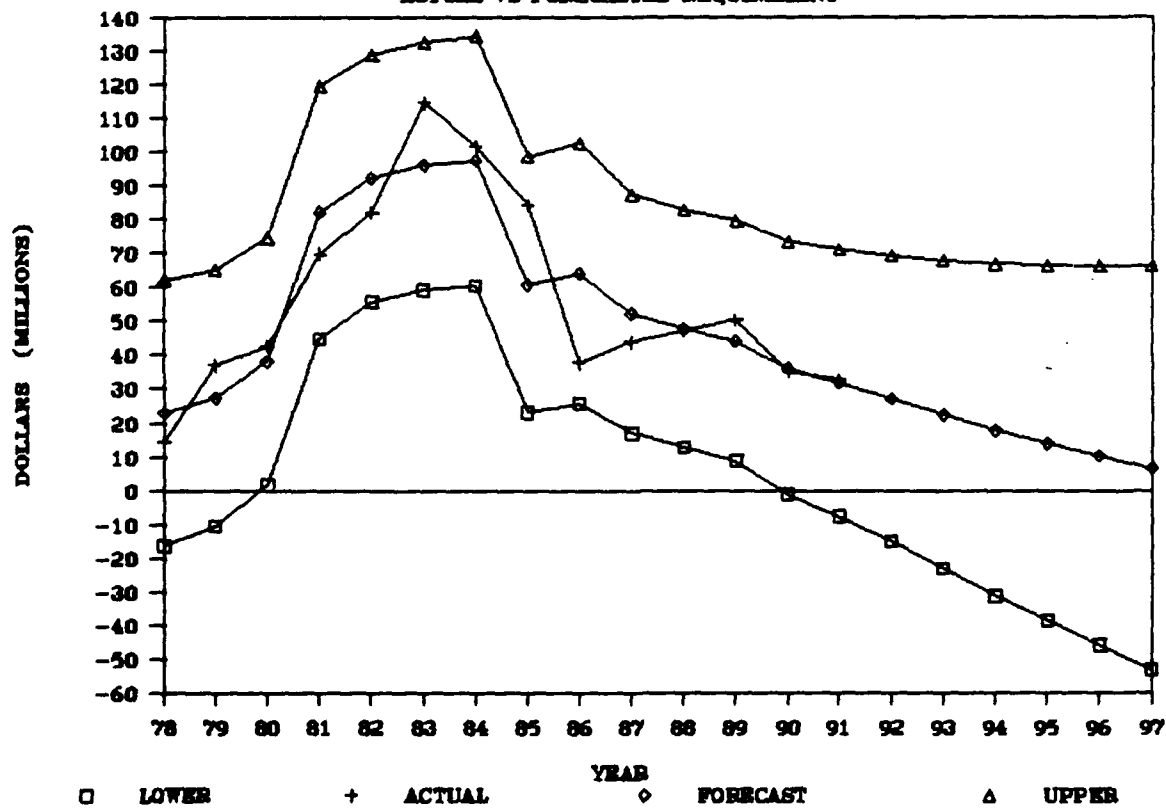
A-7 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



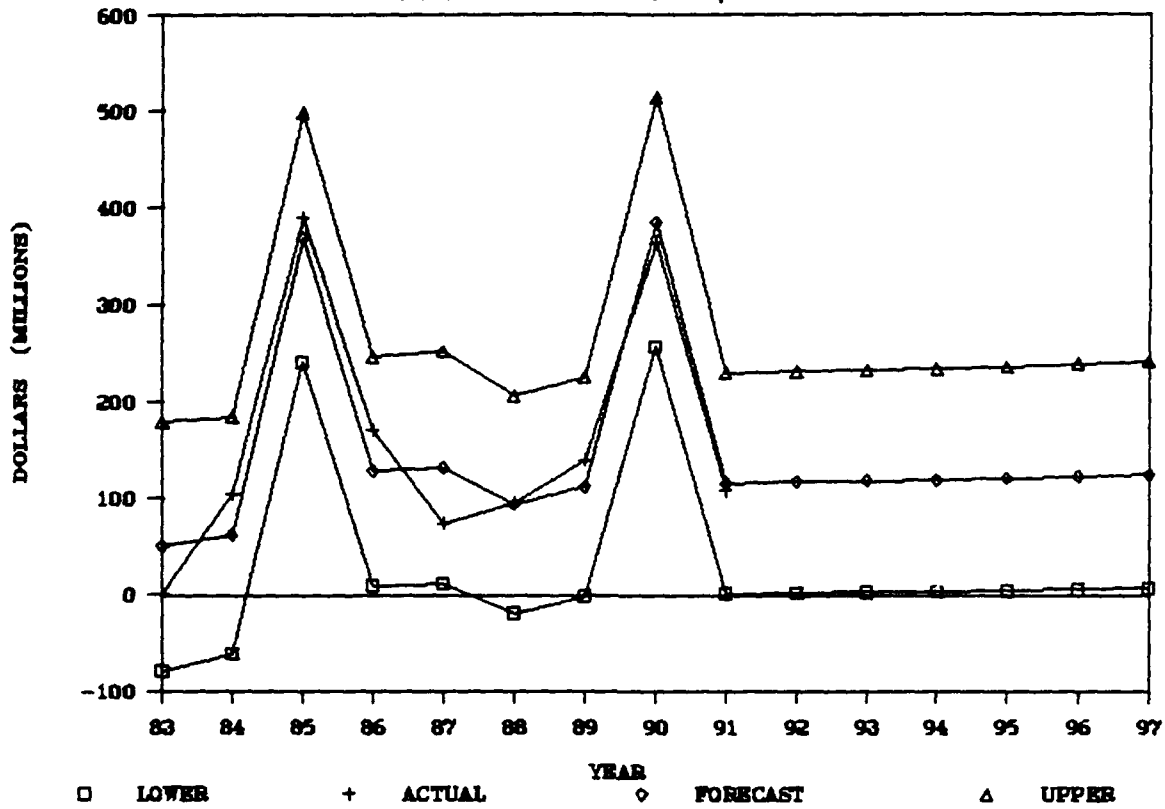
A-10 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



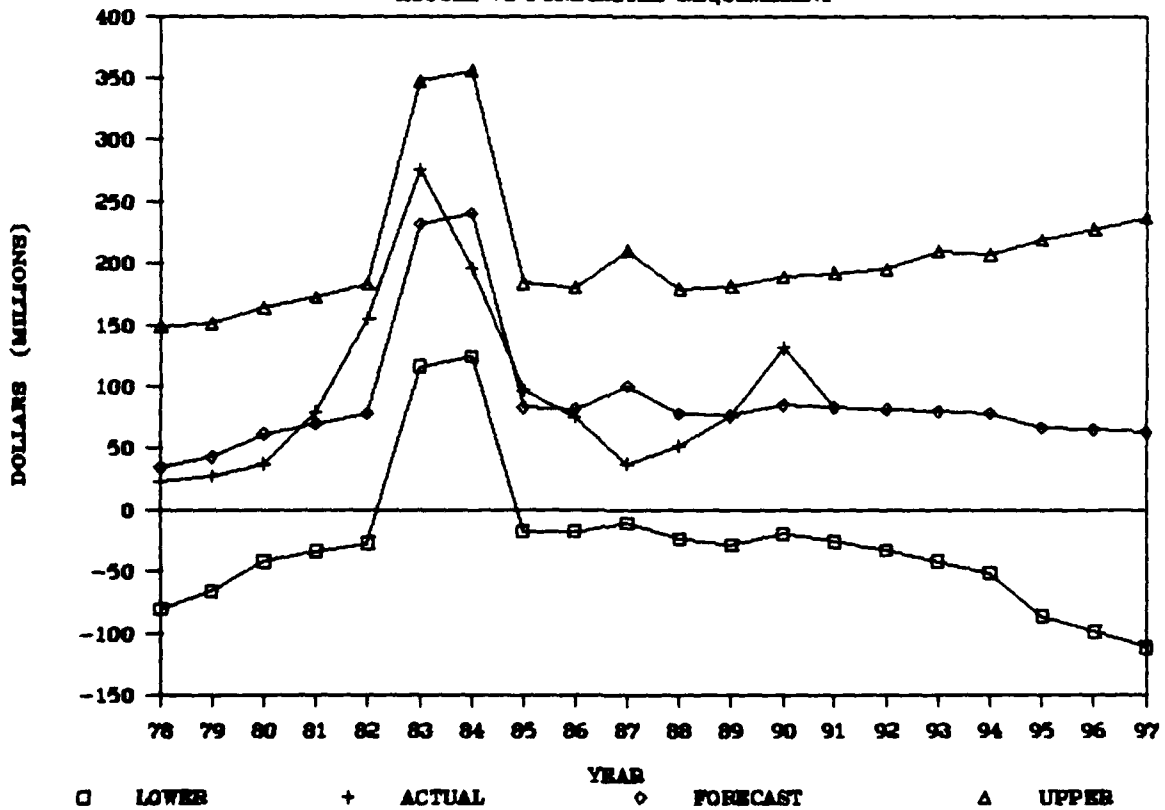
B-1 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



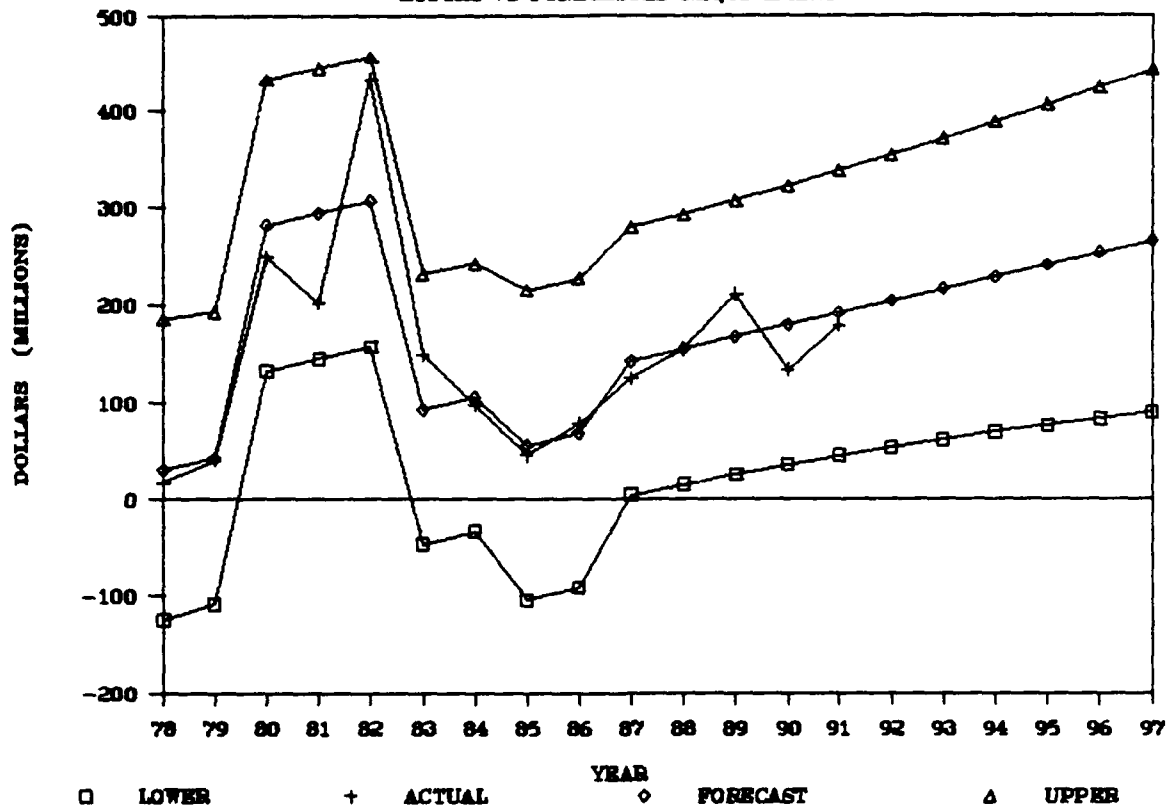
B-52 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



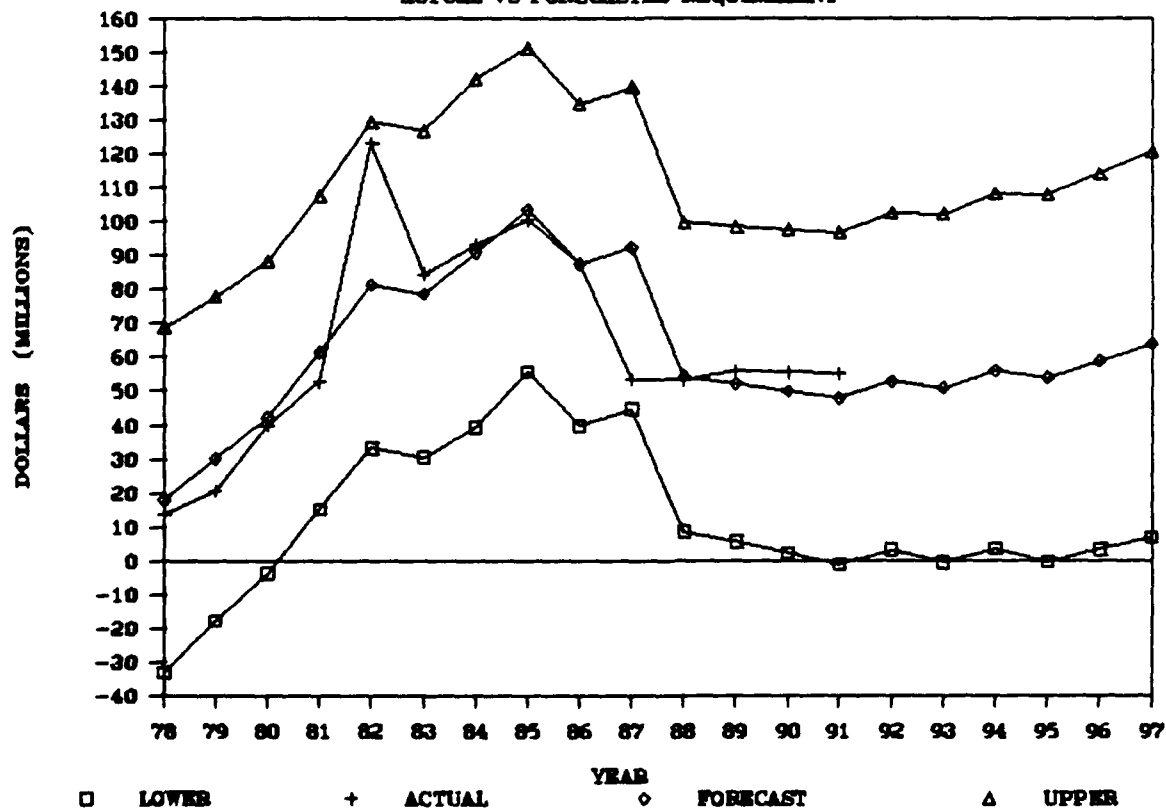
C-5 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



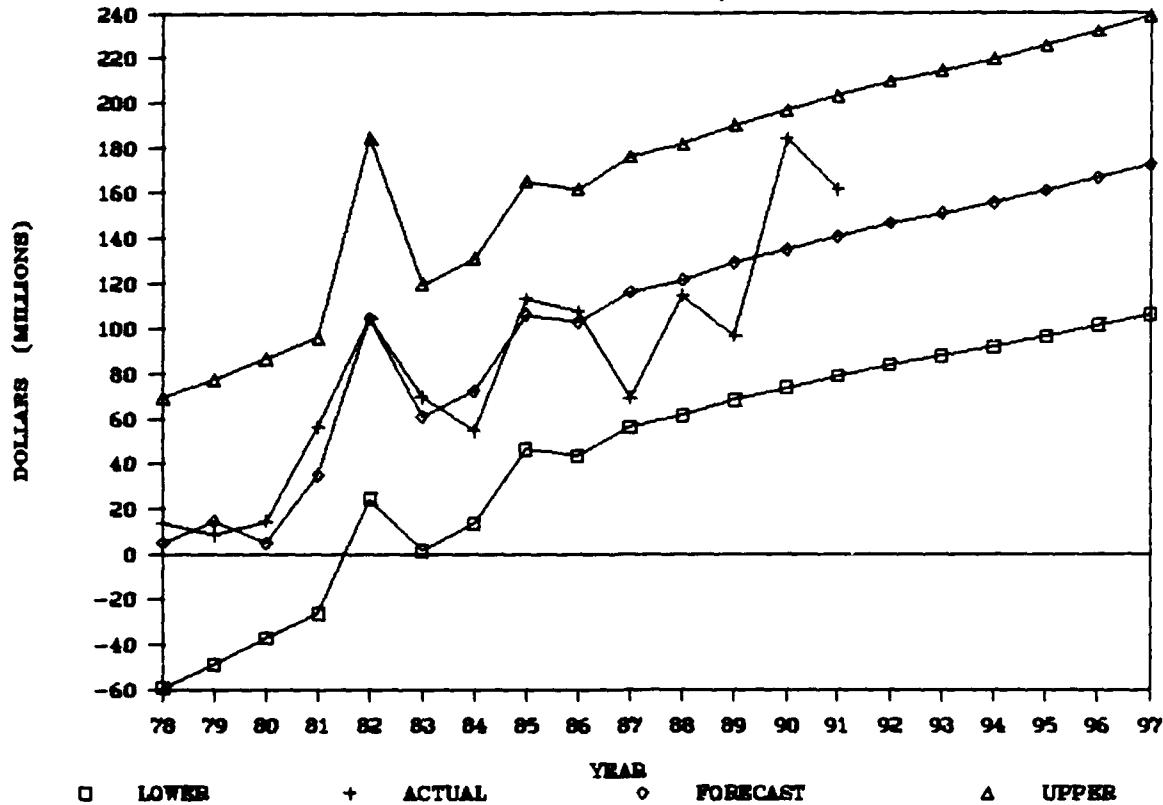
C-130 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



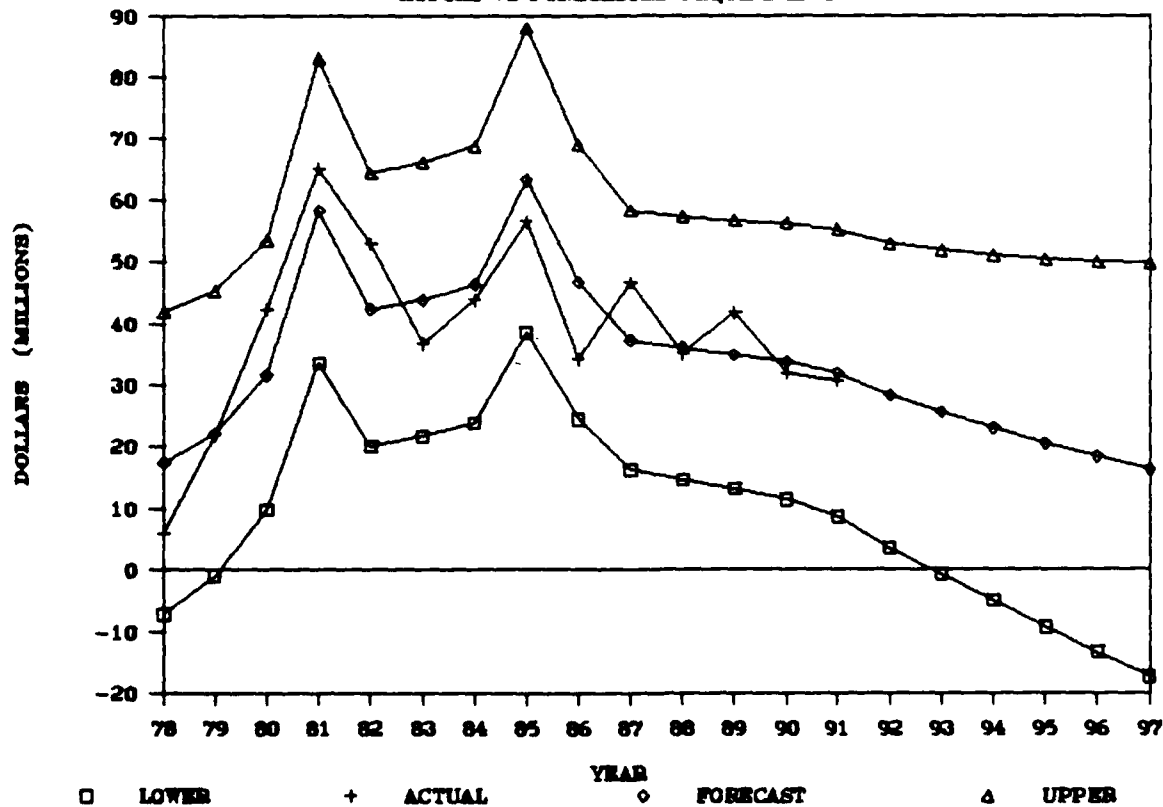
C-135 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



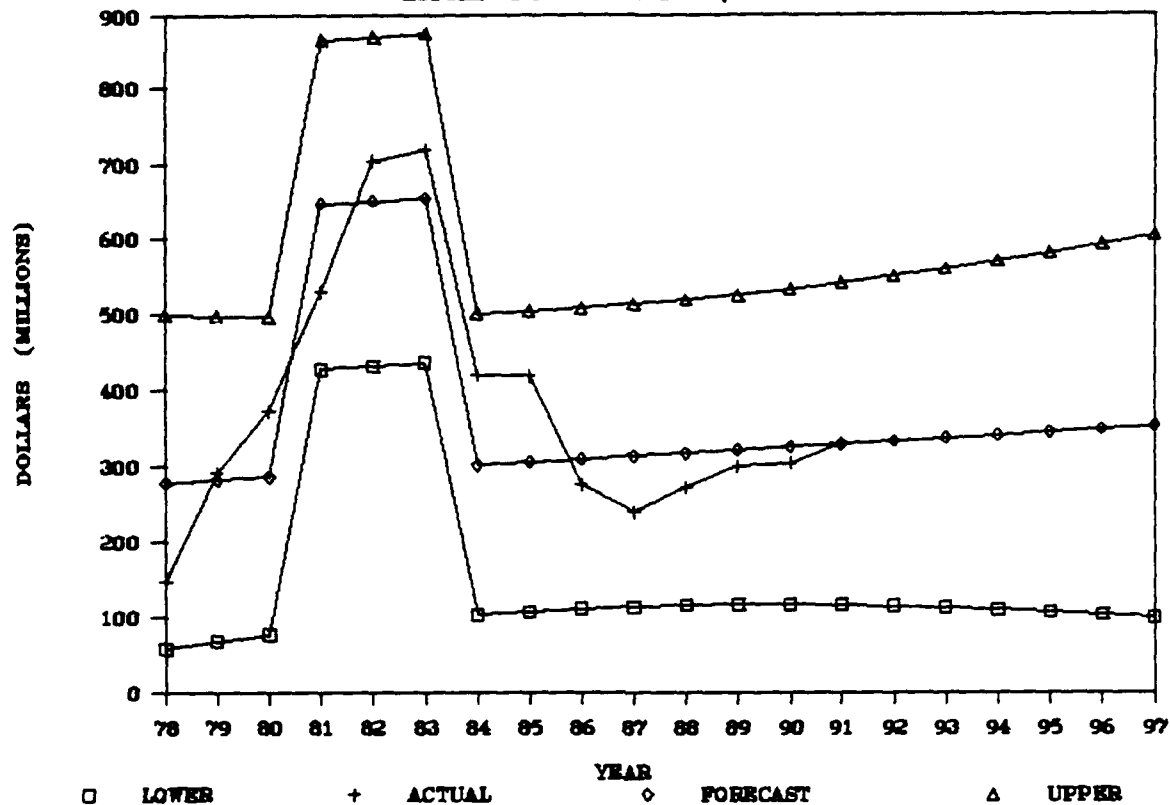
C-141 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



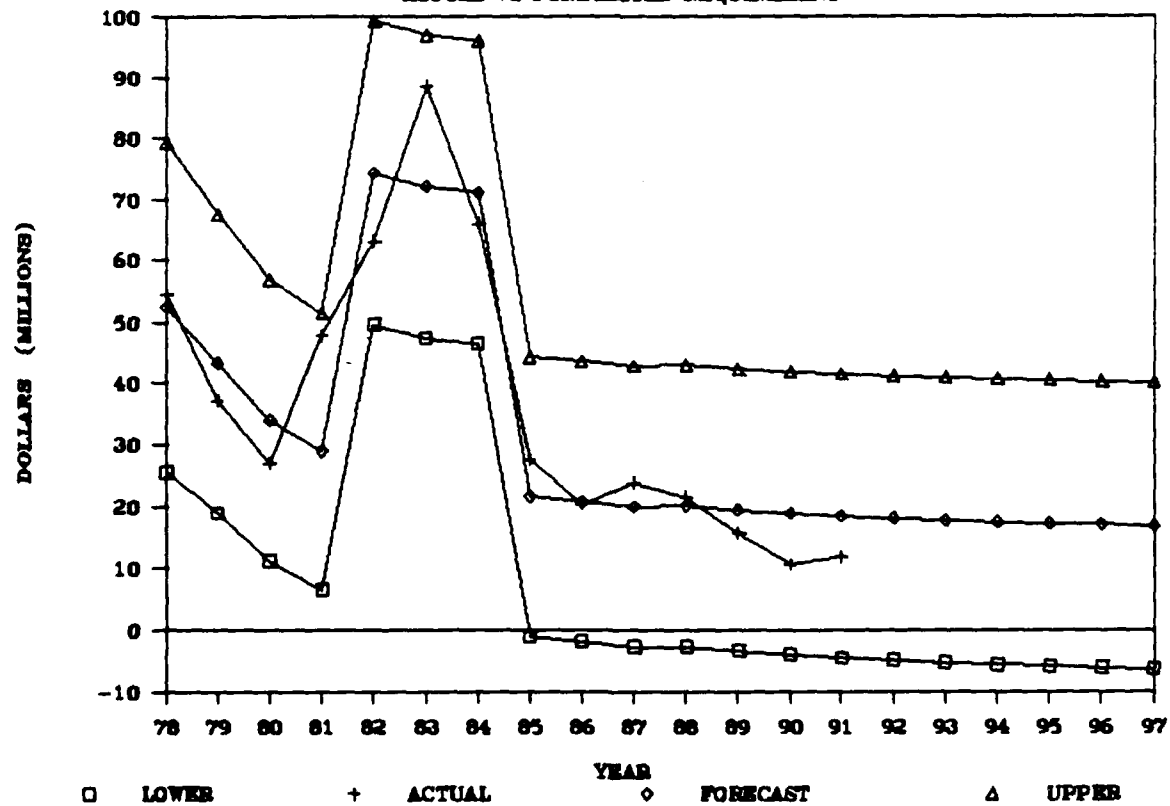
COMMON ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



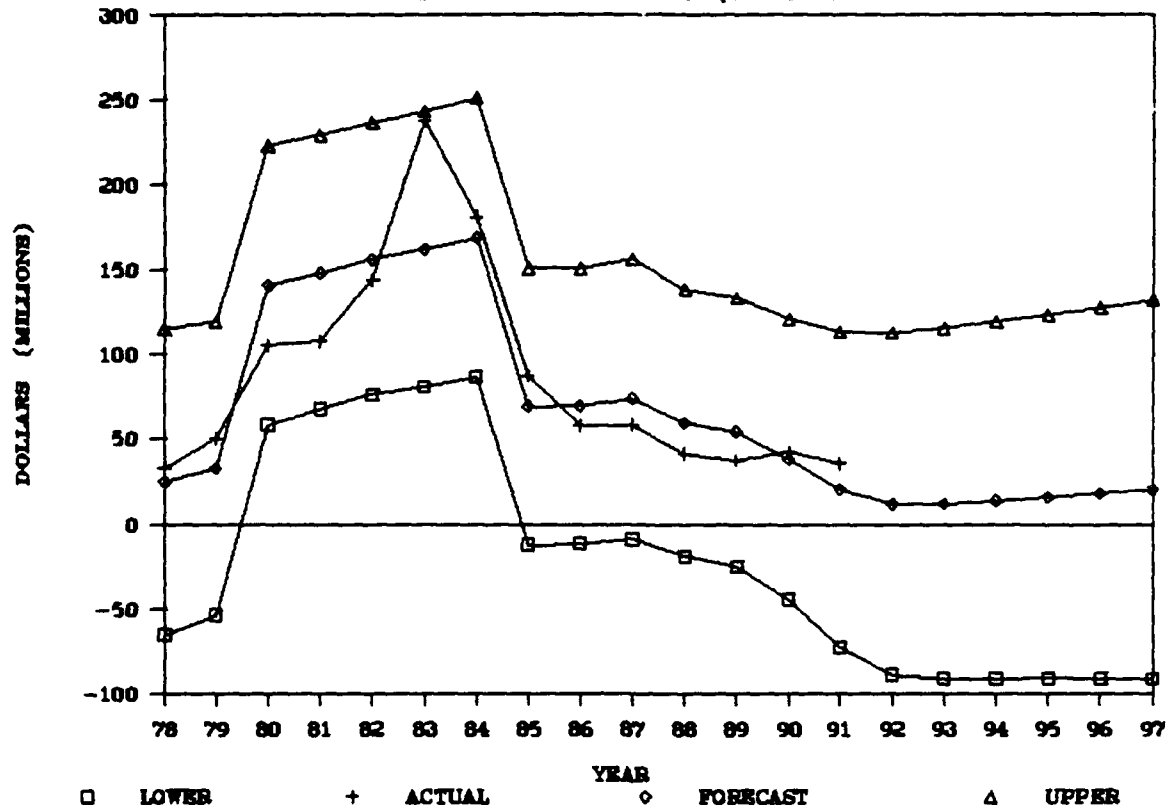
E-3 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



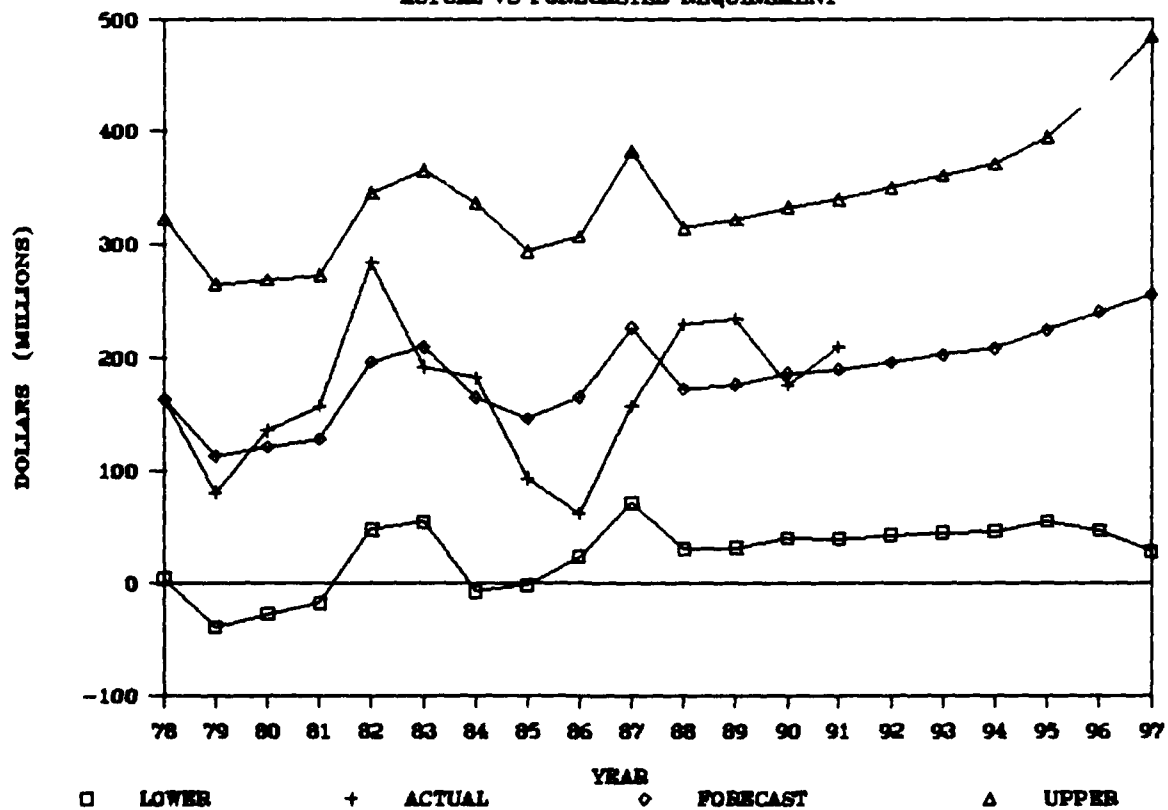
F-4 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



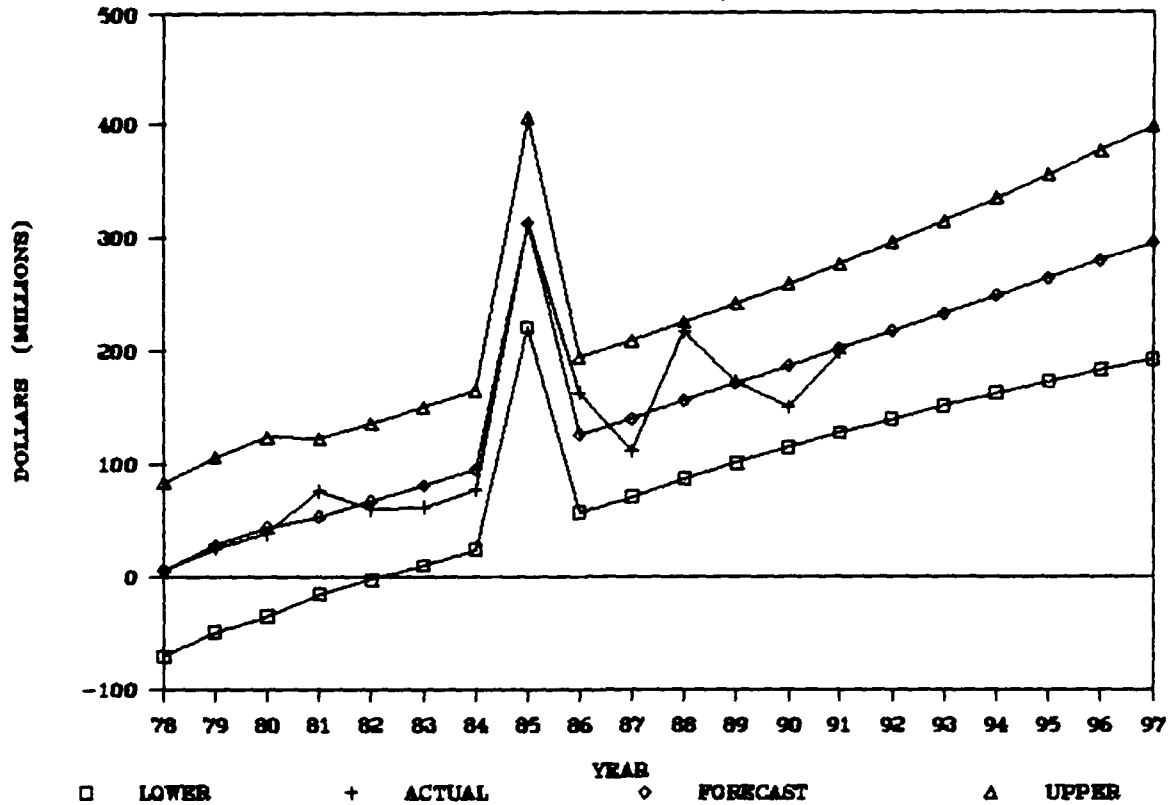
F-15 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



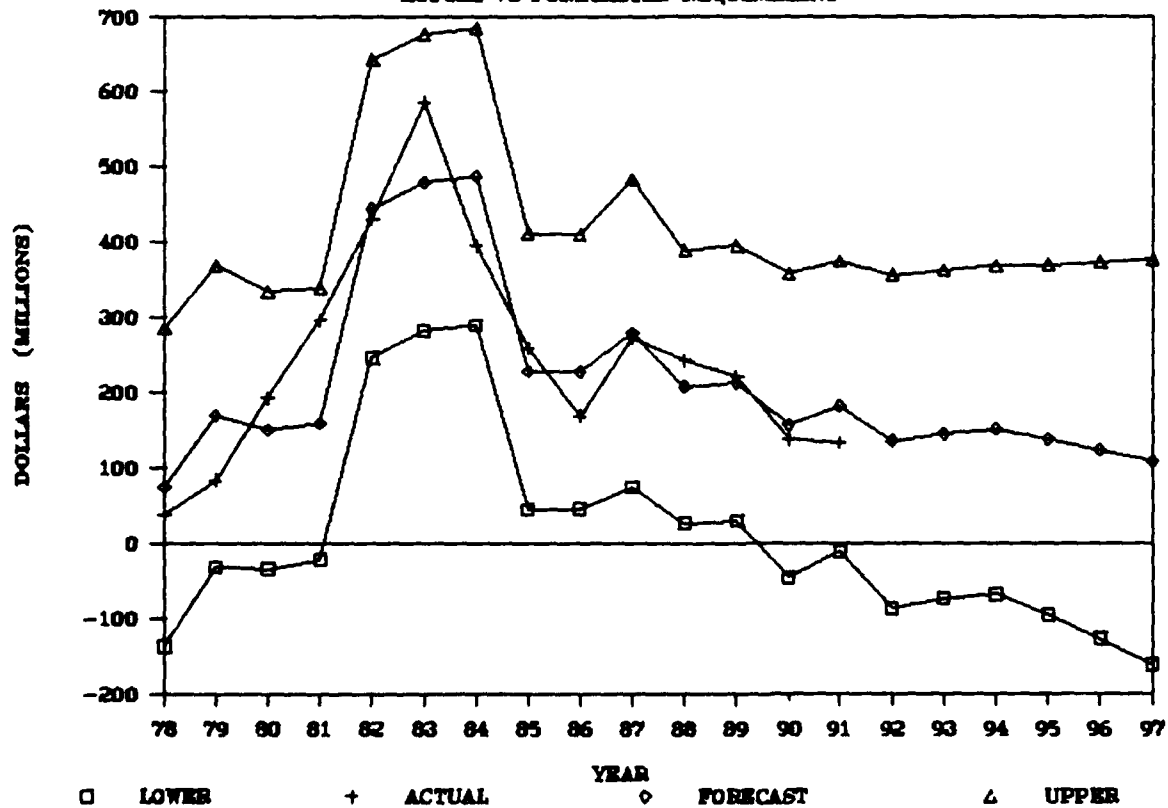
F-16 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



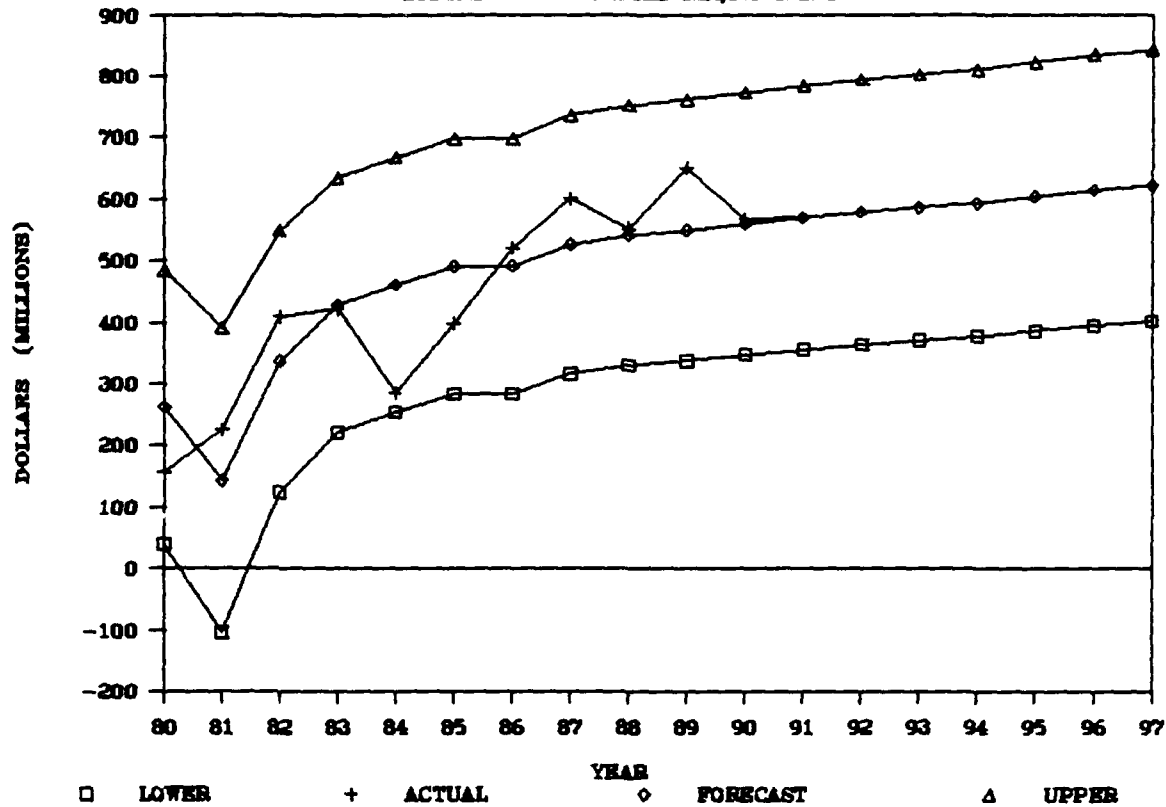
F-111 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



F100 ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT



OTHER ALERT FORECAST

ACTUAL VS FORECASTED REQUIREMENT

